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Forest Research Note

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BIRCH SEEDS WILL GERMINATE UNDER A WATER-LIGHT TREATMENT WITHOUT PRE-CHILLING

The seed of yellow and paper birches, like that of many other species, often exhibits delayed germination, which apparently is due to embryo dormancy.[1] Stratification is usually recommended for overcoming this dormancy before the seed is sown or before it is tested for germination. This involves a chilling treatment for 1 to 2½ months, which is best done under controlled temperatures with the seeds layered in a moistened porous material such as sand or sphagnum moss. For testing germination, seeds are transferred after stratification treatment to flats or germinators held at about room temperature. Since the seeds must be kept moist, this requires either a special setup to provide the moisture, or frequent manual waterings. The method is time-consuming, and the requisite facilities are not always available.

Two reports in the literature led us to suspect that prolonged cold-stratification and the customary procedure for testing germination could be bypassed by placing the seeds in water under suitable conditions of light. Wareing and Black had found that unchilled seeds of *Betula pubescens* will break dormancy in light.[2] And Redmond and Robinson had reported that yellow birch seed coats contain a water-soluble substance that inhibits growth of the embryos, but that this substance loses its inhibiting properties when exposed to light.[3]

[1] U. S. Forest Service. Woody plant seed manual. U. S. Dept. Agr. Misc. Pub. 654. 416 pp., illus. 1948.

[2] Wareing, P. F., and Black, M. Photoperiodism in seeds and seedlings of woody species. In Physiology of forest trees (Ed., K. V. Thimann). 678 pp. New York. 1958.

[3] Redmond, D. R., and Robinson, R. C. Viability and germination in yellow birch. Forestry Chron. 30: 79-87. 1954.

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EXPERIMENT STATION

We accordingly undertook some simple tests to see whether unchilled yellow birch and paper birch seeds would break dormancy and germinate in water when exposed to artificial light.

Procedure

The work discussed here was all informal and exploratory, and was done in a piecemeal manner as time permitted over a 2-year period. There were no refined experiments, no rigorously controlled comparisons of variables.

Mature strobili of paper and yellow birches were collected, air-dried for a day at room temperature, and stored at room temperature in paper containers. The first tests were started 1 week later. Other tests were conducted from time to time. The longest storage periods tested were 14 months for paper birch and 26 months for yellow birch. Size of the test samples ranged from 100 to more than 1,000 seeds per species. All together, some 20 separate tests were made, involving more than 15,000 seeds of each species.

In the tests, the seeds were placed in petri dishes partly filled with tap water, and then exposed to one of several types of artificial light. The same light sources were not always available, but those used always were either fluorescent room light, fluorescent or incandescent desk lamp light, or a combination of these types. Lights were left on for either 8 or 24 hours per day. Intensities varied from 80 to 420 foot-candles. In addition, more than 1,000 seeds of each species were tested in total darkness.

A single test period was always 3 weeks or longer. Observations were made 3 times per week. Emergence of the radicle from the seed coat was accepted as evidence that dormancy was broken and germination had started.

Results

The results clearly demonstrated that unchilled seeds of paper and yellow birches will break dormancy and germinate when immersed in water and exposed to artificial light. That is the basic finding from the tests. With immersion and illumination, some seeds of both species germinated in every trial, regardless of seed age (within the limits tested) or type of light.

The test of immersed seeds in total darkness showed that light is essential to prompt breaking of dormancy and germination. In darkness, none of the yellow birch seeds and less than 1 percent of the paper birch seeds germinated in 30 days. With illumination, germinations as high as 95 percent for paper birch and 75 percent for yellow birch were

obtained in 20 days. Germinations higher than 50 percent were obtained in many of the tests. The lowest germination in any water-light test was 11 percent.

The 11-percent germination was on a small (100-seed) sample of paper birch seed after 4 months' storage. The light treatment was 350 foot-candles, 8 hours per day, from a fluorescent lamp of the "daylite" type. Yellow birch seeds also germinated rather poorly under this treatment. It is suspected that the daylite type of light is comparatively ineffective. However, this light type was used in only one test of each species, so the evidence against it is by no means conclusive. In all other tests involving fluorescent light, the "cool-white" type was used.

The first germination in a test usually appeared in 3 to 8 days. The main surge of germination occurred at about 2 weeks (fig. 1), and was

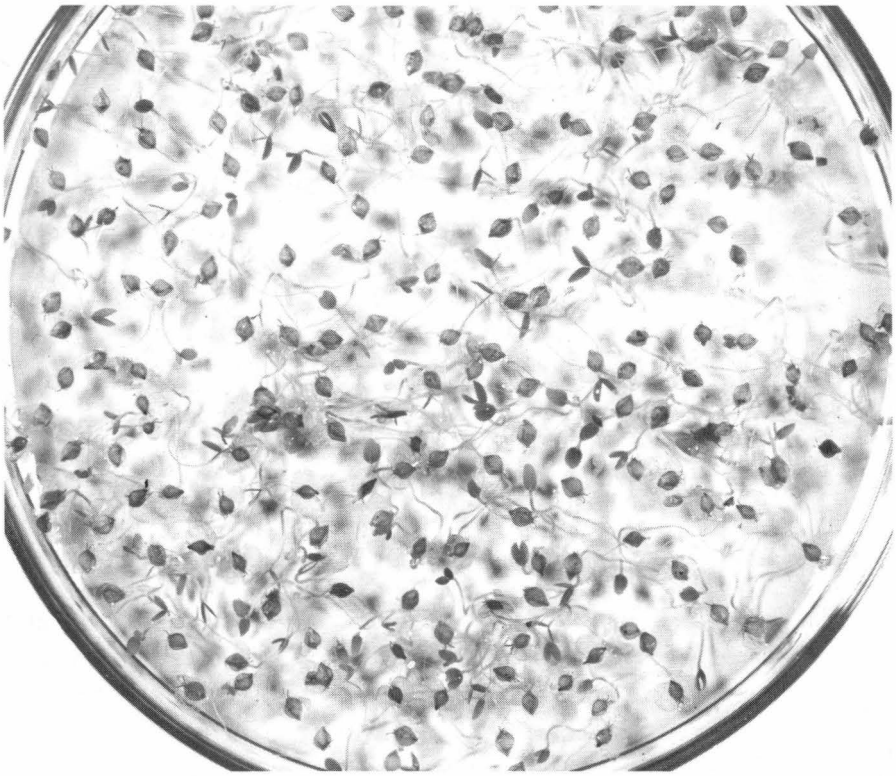

Figure 1. — Unchilled paper birch seeds germinating in tap water in a petri dish. The light treatment was 80 foot-candles of cool-white fluorescent room light for 8 continuous hours per day. Seeds had been in storage for 3 weeks. Photographed on the 15th day after treatment was started.

completed, or practically so, within 3 weeks. When placed in the water, some seeds sank and others floated, but all seemed to germinate equally well. Fungi appeared on some seeds during the tests, usually at the point where the radicle emerges. Most such seeds did not germinate.

Germination data from three selected tests are presented in table 1. The first two columns (tests 1 and 2) show some results for the two species under the same test conditions. The second and third columns (tests 2 and 3) show results for two samples of yellow birch seed from the same lot under different test conditions. These data merely represent some of the better test results; no conclusions as to species differences or effects of different treatments should be drawn from them. The data do show that fairly high, and probably almost complete, germination can be obtained by the immersion method.

Table 1.--Germination data from 3 selected tests

No. of days after start of test	Germination percent (cumulative)		
	Test No. 1 paper birch*	Test No. 2 yellow birch*	Test No. 3 yellow birch**
3	11	1	--
5	--	--	8
7	56	14	30
11	87	22	61
15	91	40	72
19	92	43	75

*Samples of 1,000 seeds, placed in tap water and exposed to 80 foot-candles of cool-white fluorescent room light for 8 continuous hours per day. Seeds stored 2 weeks before the test was started.

**Sample of 1,000 seeds, placed in tap water and exposed to 80 foot-candles of cool-white fluorescent room light for 8 continuous hours per day plus 320 foot-candles of incandescent desk lamp light for 24 hours per day. Same seed lot as in Test 2, but stored 4 weeks.

Fresh seed (less than 1 month old) usually germinated faster and in higher percentages than year-old or older seed. This might be expected, since birch seeds have been reported to lose viability rapidly after about 18 months of open storage at room temperature.[1] The oldest seeds that were tested germinated as follows (1,000-seed samples):

Yellow birch, stored 26 months — 36 percent.
Paper birch, stored 14 months — 24 percent.

These samples were exposed to 80 foot-candles of cool-white fluorescent light for 8 hours per day.

Although the results of these tests do not justify conclusions regarding the comparative efficacy of different light treatments, it was observed that yellow birch seeds seemed to require more intensive light treatment than paper birch seeds for maximum germination.

Discussion

Two major points are brought out in this report:

- That seeds of yellow and paper birches will tolerate excessive moisture and will, in fact, germinate in a free water medium.

- That, under artificial light, seeds of these birches will germinate in a water medium without benefit of pre-chilling or other treatment to break dormancy.

The practical implications of the above findings are that germination tests could be run on these two species (and perhaps others) by the simple procedure of placing the seed in water under suitable illumination. The customary prolonged cold-stratification could be bypassed, and no special germinators or frequent manual waterings would be required.

The results reported here represent only the basic demonstration that untreated yellow and paper birch seeds will germinate in water under lights. Additional experimentation is needed to determine optimum light and temperature conditions, effects of age of seed, importance of fungi and, if necessary, how to control them, and relationships of other possible contributing factors, such as acidity of the water.

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